# Sustainable Strategies

## *The Eco-nomics and Environmental Value of Integrated Planning*

David Del Porto

November 5, 2005

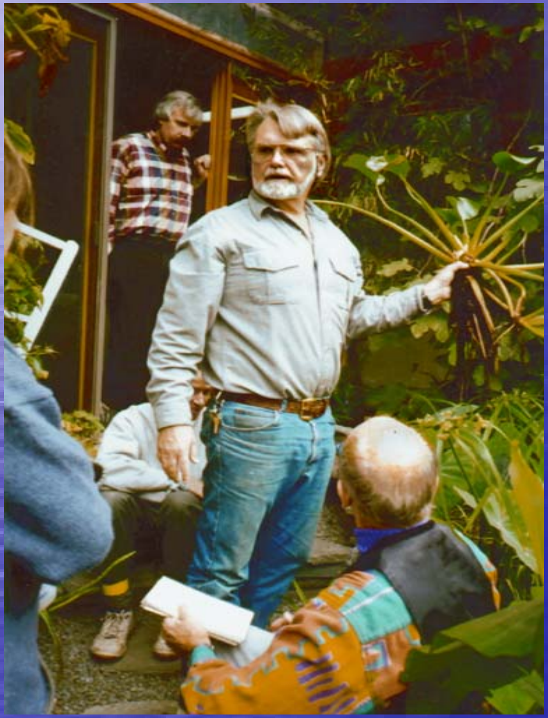
Beyond Sewering Conference

Massachusetts Riverways Programs

Bridgewater State College

# David Del Porto

## Lecturing from the greenhouse of his solar-heated home in Newton Massachusetts



- Ecological Engineering Group, Inc.

  *where Life informs Design®*

- www.ecological-engineering.com
- 50 Beharrell Street, Concord, MA 01742
- 978 369 9440

"In the last twenty years, communities have spent $1 trillion in 2001 dollars on drinking water treatment and supply and wastewater treatment and disposal.

This spending is impressive, but it may not be sufficient to keep pace with infrastructure needs of the future."

EPA-816-R-02-020
September 2002

# What are the cutting-edge solutions you can use today to deal with this problem?

- Sustainable Design Principles
- Integrated Water Management
- Low Impact Development
- Ecological Storm and Wastewater Treatment
- LEED (Leadership in Energy and Environmental Design) Green Building Rating System® is a voluntary, consensus-based national standard for developing high-performance, sustainable buildings see: www.usgbc.org

# Design Principles

- The first step in evaluating a site for ecologically sound design is to develop and define the design principles to be used in the development process.
- The following are a few new principles for Sustainable Design:

# Principles for Sustainable Design

- Urban Watersheds©
- Ecological Design
- Wastewater no more
- Water Effectiveness
- Sustainable Maintenance

- Integrated Water Management
- Re-thinking Stormwater
- Ecological Engineering where "Life informs Design"®

# Urban and Industrial Watersheds©

- Consider the site and adjacencies that impact the site as a unique watershed ecosystem with diverse inputs, outputs and opportunities.
- This represents a shift in thinking towards analyzing a site as a near autonomous system where the inputs and outputs must both be managed locally.
- In doing so, many opportunities become available to reuse or recycle inputs and outputs from the various systems.

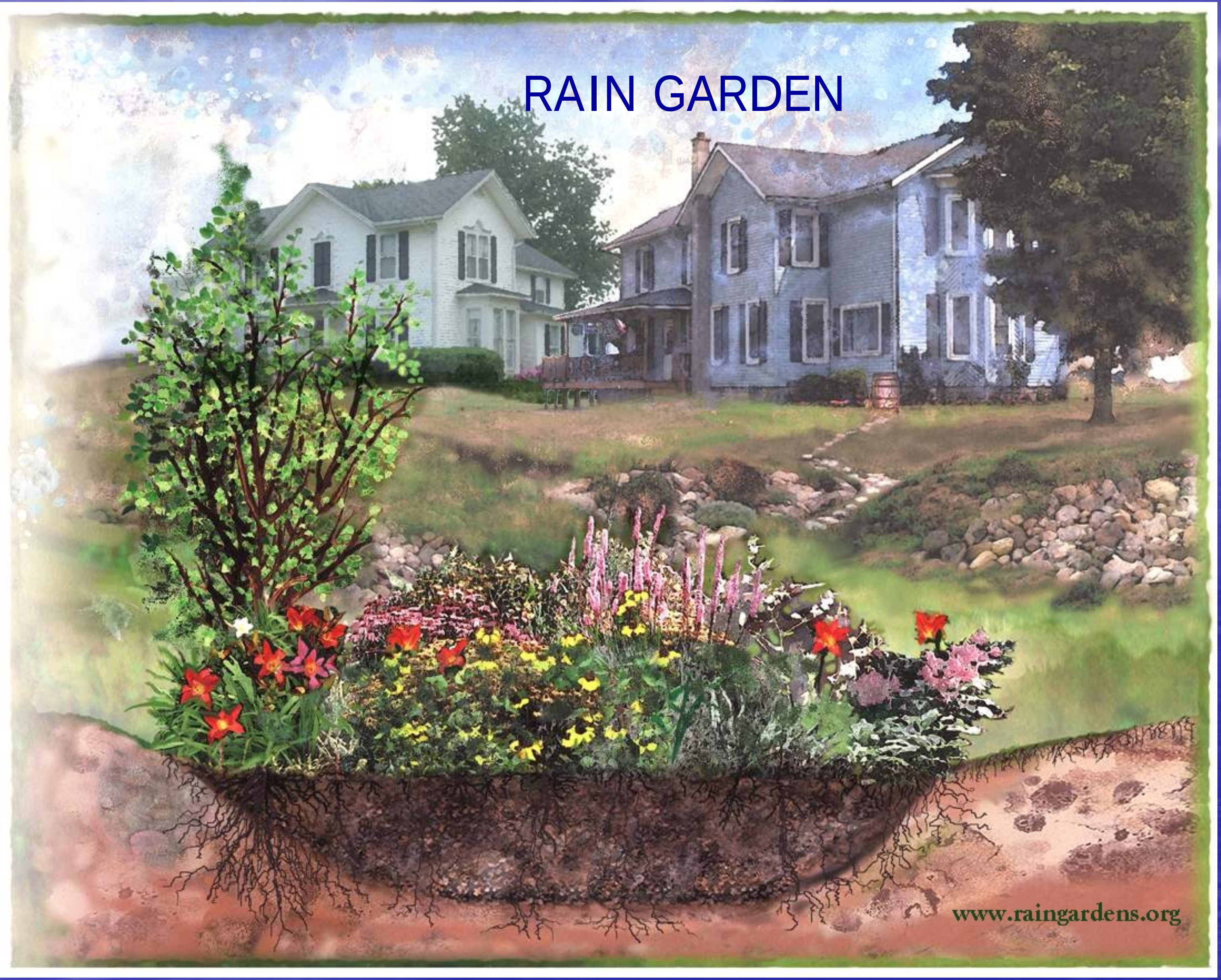
Planning and design are informed by hardscapes – roofs, parking lots and streets.

Collection, storage, reuse and recharge are the challenges for future Urban and Industrial Watersheds.

# Low Impact Development

- Strategies for tightening the site hydrologic cycle
  - No run off
  - Reuse
  - Recharge

- Should the goal be maintaining and enhancing the **pre-development** hydrologic regime of urban and developed watersheds?  I think not.


RAIN GARDEN
www.raingardens.org

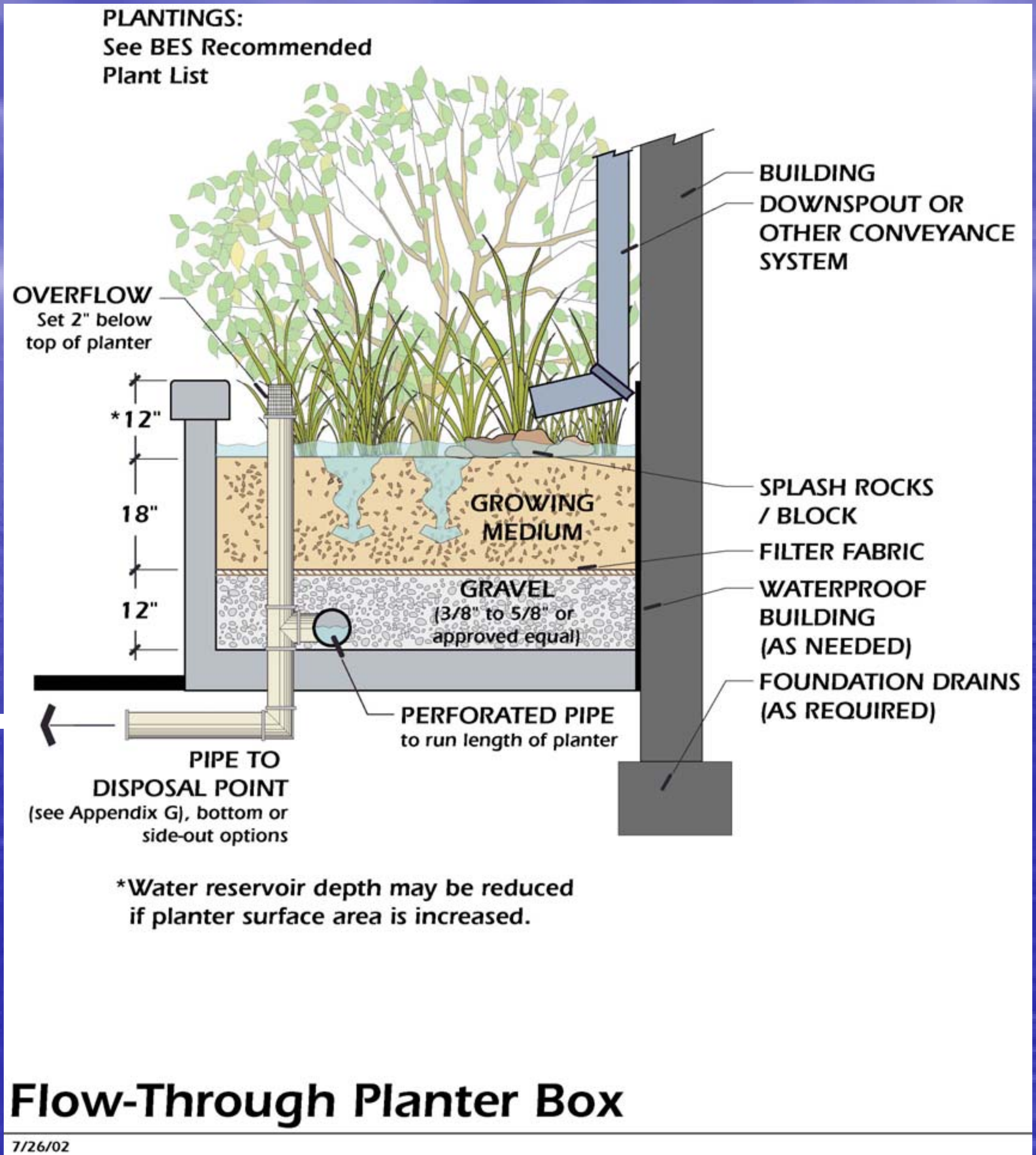
www.ecological-engineering.com

# Retrofitting existing buildings

# Collection plus Treatment

First to STORAGE

Then to RECHARGE



# Ecological Design

- Derived from the observation of stable ecosystems in which the outputs of some systems are the inputs for others.
- These systems have unique attributes such as interdependent living and non-living elements that cascade energy, water, matter and information in circular pathways.
- Sequenced inter-connected ecosystems provide the greatest value for the lowest cost for both stormwater and effluent utilization.

# Wastewater no more

**Water does not become wastewater if it not “wasted”.**

- Maximize the reuse of stormwater and wastewater for irrigation, toilet and urinal flushing and makeup water for evaporative air conditioning.
- By intercepting the normal treatment process at the secondary level, nutrients in the effluent can be used to grow valuable but non-edible plants by diverting partially treated wastewater to lined and managed growing beds or gardens in developed areas and farms on barren land.

# Eco-Energy - The new paradigm

- Growing alternatives to imported petroleum may be the highest value for secondary effluent based on projected energy prices.
- Perhaps we should invest some of the next trillion dollars in pipelines to transport secondary effluent to barren Eco-Energy farms instead of expensive tertiary treatment in order to better dispose of wastewater in receiving waters

# Water Effectiveness

- The true solution to managing excess water and wastewater is to prevent its generation in the first place.
  - Efficiency is not always Effective
  - Effective means producing the intended result
  - Water reuse is effective
  - E.G. saving warm-up water from a low flow showerhead and using it to flush a 1.6 gallon toilet to minimize wastewater is “effective”
  - My wife would prefer an effective relationship – not an efficient one

# Sustainable Maintenance

- This occurs when the output of a system provides a value that equals or exceeds the cost to manage that system.
  - An example might be the plants grown with wastewater that have a higher value to the user than the cost of care.

# Principle-based Design

- By incorporating these over-arching principles into a project, we seek to provide new value-driven criteria
- which holistically address the site issues
- while reducing the life-cycle cost to both the owner and the community.

# Effective Integrated Water Management

Efficiency

plus

Wastewater and Stormwater Reuse

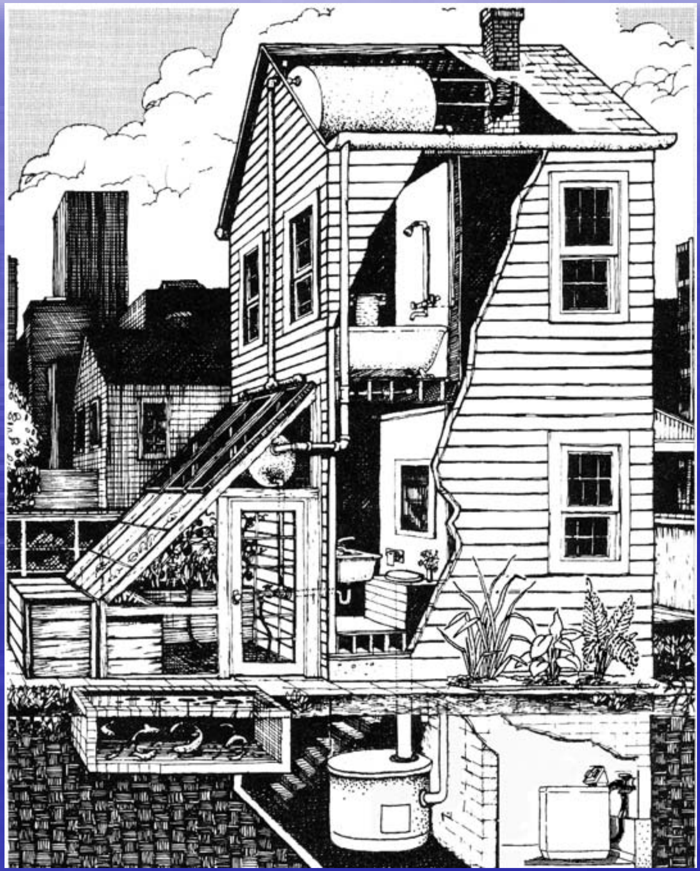
# First Conserve

## Manage the Demand

- Remember: Indoor Water demand = Sewage production
  - Specify products that exceed plumbing code minimums
  - Select plant species to minimize the need for irrigation (Xeriscape)
  - Computerize irrigation to provide only the minimum amount of water needed
  - Recycle water for irrigation and toilet flushing
  - Retrofit existing buildings

Minimize long collection and distribution systems. They are too expensive unless their life cycle is 2,000 years or more.  Collection can be 80% of new system costs. On-site water collection and wastewater treatment is the solution

# Complete Integration



The Integral Urban House

Farallones Institute
Berkeley, CA
1973

An ecologically retrofitted Victorian house in the city.

# Urban & Industrial Watersheds an Integrated Water Management Strategy

- Differentiating this approach from others in the realm of water management is the vision of urban, commercial, and industrial hardscapes as watersheds that collect water.

- We ask how much water and wastewater can be collected, stored and recycled in order to preserve the available water supplies, prevent pollution and reduce the costs associated with water supply, storm and wastewater treatment.

# Re-thinking Stormwater as a resource

- Stormwater has only been viewed as a problem that must be shed quickly from the site so as to pose no problems to the site or its users.

- When inadequate water supply or quality is a concern for a site or community, the collection, storage and reuse of stormwater becomes an attractive prospect.

# Eco-nomics of Stormwater

- Every day, more than 678 million gallons of stormwater are discharged into the rivers from New York City.
- This represents 61.6% of the daily water demand for the city.
- If the stormwater was priced at the water rate, then the storm water would be worth more than $1.3 million dollars per day!

# Storage is the key issue

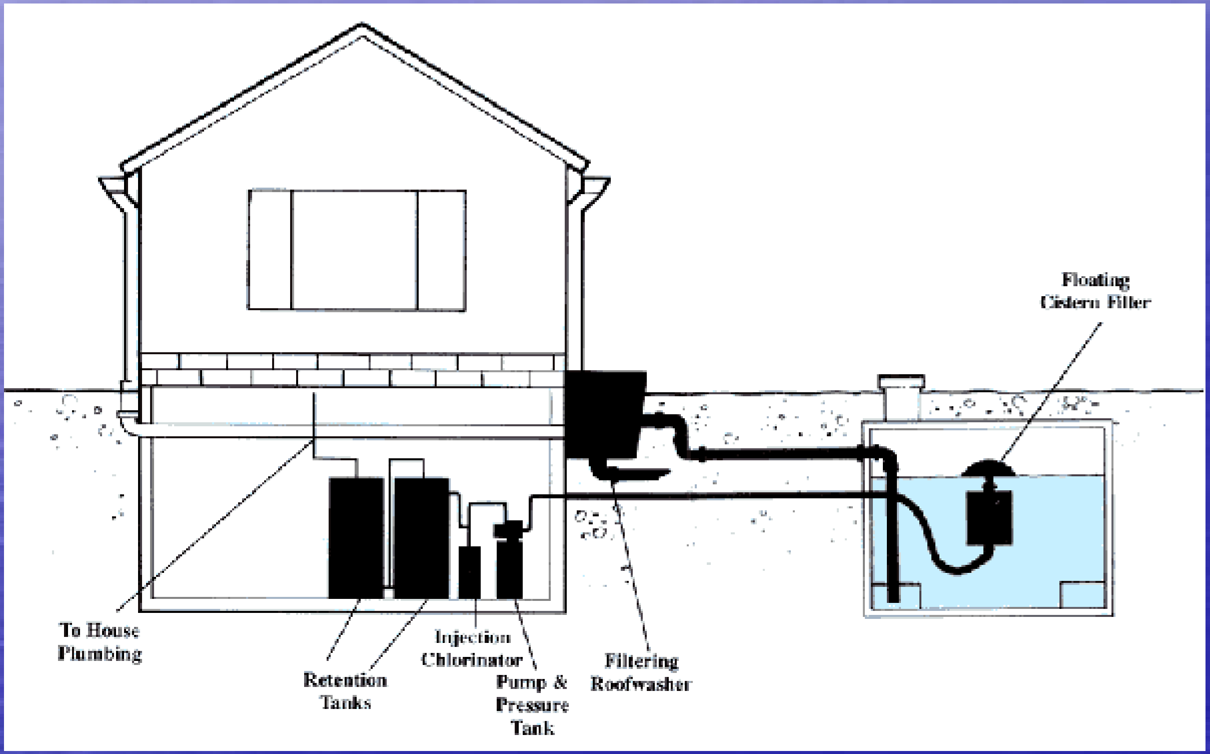
Above ground

or

Below ground

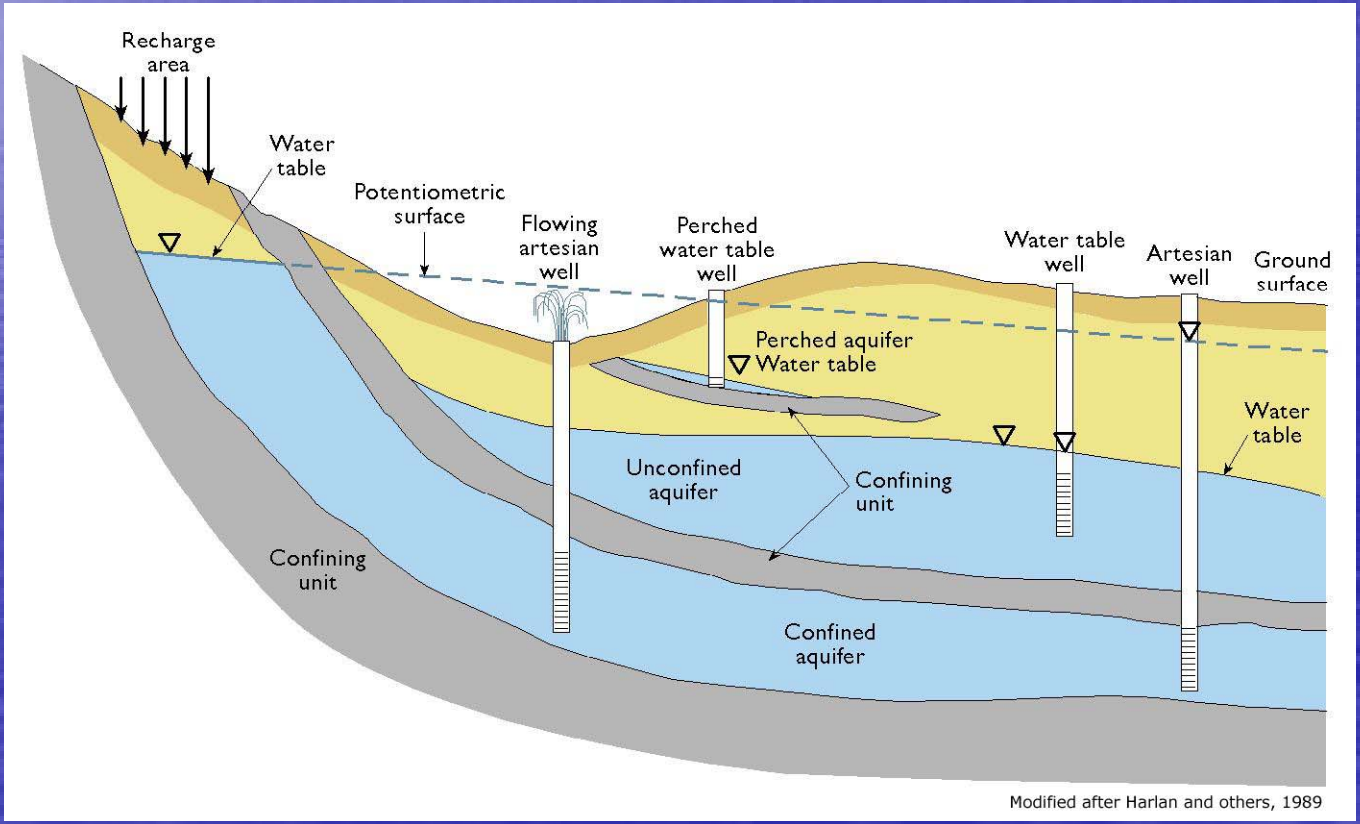
www.ecological-engineering.com

# Cisterns cost approximately $1.00 per installed gallon stored



# Constructed Aquifers

require 3 times the volume but at half the cost. Porosity of packed stone = 33% of the total volume are voids that store water



# Ecological Engineering

- The term was first coined by the system ecologist, Dr. Howard Odum, in 1962
- Planning, engineering and design with the system ecology paradigm as a template is the work of a new discipline called *ecological engineering*.
- For example, the ecological paradigm reveals how to safely utilize all of the polluting components of stormwater and wastewater.
- **Designers no longer need to presume wastewater – if it’s not wasted!**

# Where Life informs Design®

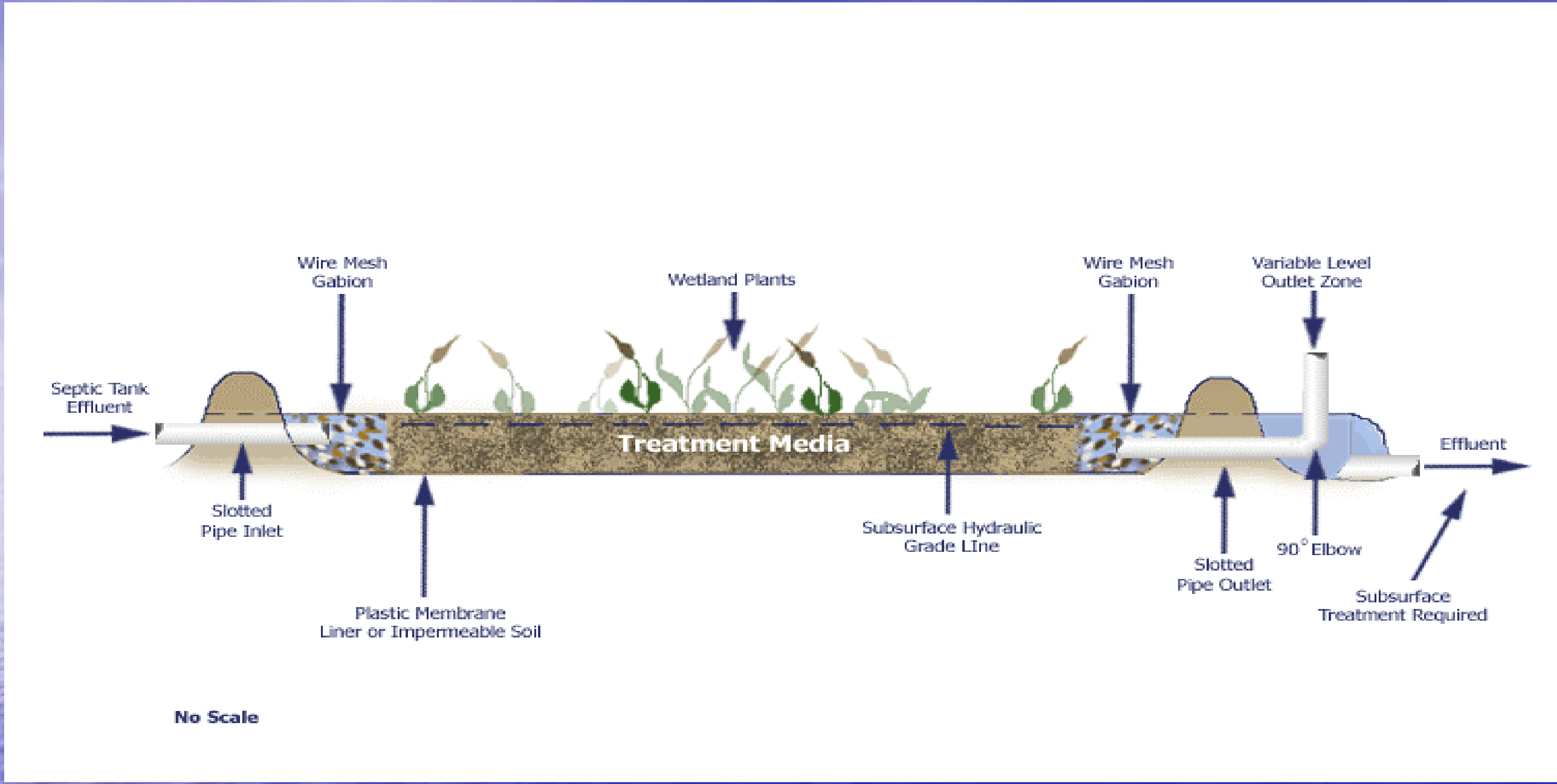
- **3.9 billion years of evolution has optimized the efficiency of living organisms as ecosystems to utilize sunlight, minerals and nutrients.**

- **Life (with a capital “L”) and ecological design are typified by:**
  - **Self-organization**
  - **Self-repair**
  - **Adaptation and**
  - **Procreation**
  - **a proven sustainable strategy for pollution prevention**

**What conventional wastewater treatment systems have we ever built that can do that?**

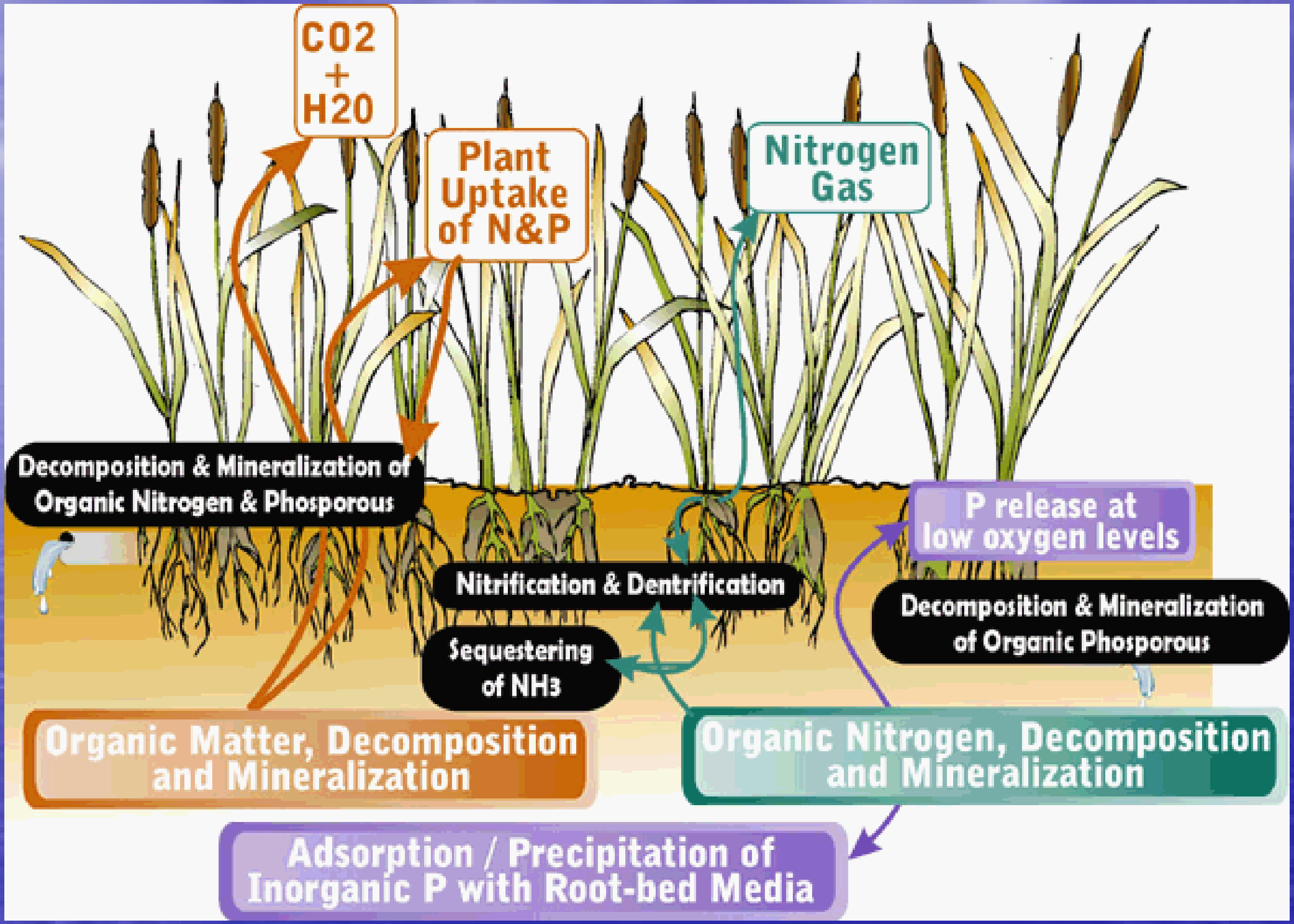
# A low-cost ecological treatment system for New England

- Sub surface flow constructed treatment wetlands are better for cold climates
  - Water line at least 6” below grade
  - Owners can use the surfaces for other purposes such as recreation and education – no open water!
  - Works in Minnesota and Canadian winters
    - No surface area exposed to ambient temperature
    - Are typically insulated to prevent freezing
    - Can be deep enough to use higher below-grade earth temperatures
  - Proven effective by USEPA
  - De-nitrifies and removes phosphorous by ecological design
  - Two examples in Massachusetts – one operating for 8 years!

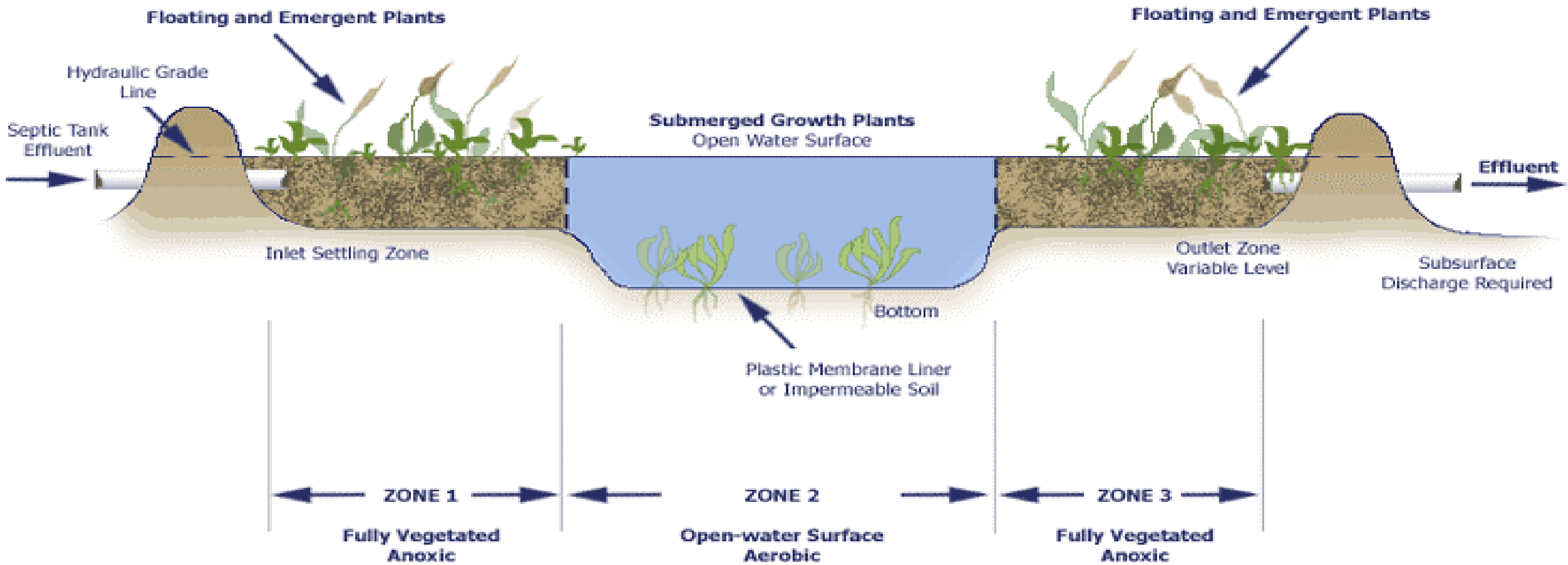



# SUB-SURFACE FLOW WETLANDS

# CROSS SECTION




www.ecological-engineering.com



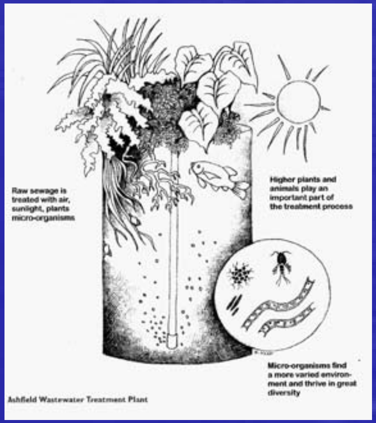

# FREE WATER SURFACE (FWS) CONSTRUCTED WETLAND CROSS SECTION

# New England Biolabs in Ipswich

# Solar Aquatic Systems

- Solar Aquatics duplicates, under controlled conditions, the natural purifying processes of fresh water streams, meadows, and wetlands. Using greenhouses to enhance the growth of bacteria, algae, plants and aquatic animals.

# Greenhouses for cold climates



# With a tropical sub-surface flow constructed wetland

# Before and After Treatment

www.ecological-engineering.com

A wonderful place for meetings or just hanging-out It's a good neighbor too!

# A New Marketing Model Emerges - Gardens and Landscapes -

- Values other than pollution prevention:
- Lower life-cycle cost
- Aesthetic – Beauty and Perfume
- Fuel, structure, food, fiber
- Oils and grasses can replace imported petroleum

- Values that people want and are wiling to pay for - versus waste treatment which they don’t want to pay for

# Zero-Discharge Recirculating Wastewater Gardens®

Instead of treatment and reuse,
we ask:

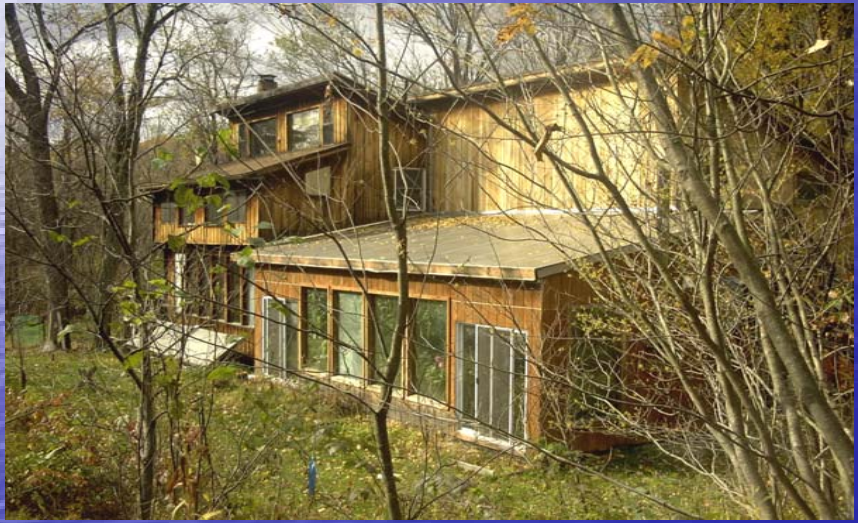
How many plants are needed to use up all the wastewater?

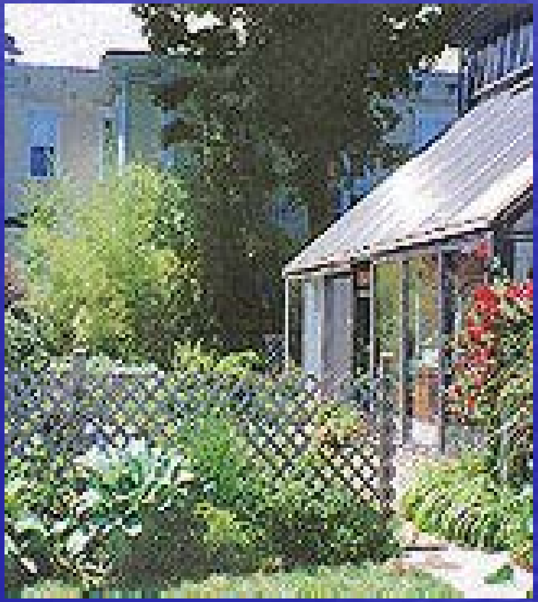
# Wastewater gardens in the landscape

# Example

- 3-bedroom residence in central Massachusetts that was be razed to prevent septic tank effluent from entering the town's drinking water well
- The solution was to separate gray and blackwater and use up the graywater in a solar heated greenhouse attached to the house.

# Recirculating Wastewater Gardens





# Characteristics of wastewater gardens and landscapes

- Similar to planted re-circulating sand filters
- Zero-discharge !
- Recycles until all the effluent until it is consumed by evapo-transpiration
- Governed by number and type of plants
- Can be vertical to save space
- Key factor: Leaf Area Index and heat

# Plants that clean up pollution or “Phytoremediation”

# Hyper-accumulation of toxic chemicals and heavy metals

- Compounds are frequently transformed in the plant tissue into less toxic forms or sequestered and concentrated so they can be removed (harvested) with the plant.
- For example, mustard greens were used to remove 45% of the excess lead from a yard in Boston to ensure the safety of children who play there. The sequestered lead was carefully removed and safely disposed of.
- Besides mustard greens, pumpkin vines were used to clean up an old Magic Marker factory site in Trenton, New Jersey.
- Hydroponically grown sunflowers were used to absorb radioactive metals near the Chernobyl nuclear site in the Ukraine as well as a uranium plant in Ohio.
- Ferns are being used to extract arsenic from soils and water.

# Wastewater Garden in Fiji Resort

www.ecological-engineering.com

# The wastewater treatment *"plant"* of the future

# Principles for Sustainable Design

- Urban Watersheds©
- Ecological Design
- Wastewater no more
- Water Effectiveness
- Sustainable Maintenance
- Integrated Water Management
- Re-thinking Stormwater
- Ecological Engineering where "Life informs Design"®

# Reference Books


- Crites, R. and Tchobanoglous, *Small and Decentralized Wastewater Management Systems* WCB/McGraw-Hill, Boston, MA 1998
- Del Porto, D. and Steinfeld, C., *The Composting Toilet System Book*, The Center for Ecological Pollution Prevention, Concord, MA 2002
- France, R., Ed., *Handbook of Water Sensitive Planning and Design*, Lewis Publishers, NY 2002
- Rogers, P., Ed., *Water Crisis – Myth or Reality*, Swets & Zeitlinger Publishers/ A.A. Balkema Publishers, Lisse The Netherlands 2005
- Vickers, A., *Handbook of Water Use and Conservation*, Waterplow Press, Amherst, MA 2002
- Wolverton, B and Wolverton, C., *Growing Clean Water*, WES, Inc., Picayune, MS 2001

# THANK YOU